Improving
BLUEGRASS PASTURES

Review of an early experiment on the effects of

Frequency of harvest

Disking

Application of barnyard manure

on yields and protein content

By W. B. NEVENS
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Bulletin 504

UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT STATION

Fig. 1.—Experimental bluegrass plots. These plots were one by four rods in area. Grass was harvested by means of a lawn mower with grass-catcher attachment.

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The investigation reported in this bulletin was carried out many years ago. W. J. Fraser, now Chief in Dairy Farming, Emeritus, was in charge of the investigation; J. M. Barnhart, Assistant in Dairy Chemistry, made the chemical analyses; and H. E. Crouch was responsible for the field work consisting of plot treatment, harvesting, etc. The tabular arrangement of the data, the charts, and the discussion were prepared by the author after consultation with W. J. Fraser.

Urbana, Illinois August, 1944

Publications in the Bulletin series report the results of investigations made or sponsored by the Experiment Station

IMPROVING BLUEGRASS PASTURES

By W. B. Nevens, Chief in Dairy Cattle Feeding

KENTUCKY BLUEGRASS has long been one of the most commonly used pasture grasses on Illinois dairy farms. There are three reasons for the popularity of this grass: (1) it makes a permanent pasture that requires little reseeding or other attention; (2) it survives despite close grazing and adverse weather; (3) the firm sod resists tramping and erosion.

There are definite limitations, however, to bluegrass pastures: (1) the dry-matter yield and protein content, which are usually high during May and the first part of June, fall off during midsummer; (2) the dry-matter yield is also seriously reduced whenever rainfall is light; (3) the total yearly yields of dry matter and of protein are low.

To find out whether the yield and feeding value of bluegrass pastures might not be improved by good management, the Illinois Station conducted a series of experiments from 1909 thru 1913. Popular discussions of the investigation were published many years ago[1] but the technical features which answer many questions being asked today about pasture management were not reported. In view of the greatly increased interest in pasture improvement in recent years, it now seems desirable to publish a synopsis of this study.

Three Management Practices Tested

A small tract on the University dairy farm was divided into seven experimental plots (Fig. 1). The land was level and well drained, had been in pasture for nine years, and was well sodded with Kentucky bluegrass.

Each plot was 4 rods long (north and south) and 1 rod wide, or $\frac{1}{40}$ of an acre in area. Woven-wire fencing surrounded the plots and kept livestock out of the enclosure.

Harvesting, disking, and manuring. A different management practice was tried out on each plot in respect to harvesting, disking, and manuring (Table 1). Each practice and combination of practices

[1]W. J. Fraser, "Ever-Failing or Never-Failing Pasture," Hoard's Dairyman 67, page 869, 1924. See also book by same author: "Dairy Farming," John Wiley and Sons, 1930.

TABLE 1.—TREATMENT AND FREQUENCY OF HARVEST AND TOTAL FORAGE YIELDS OF SEVEN BLUEGRASS PLOTS, 1909-1913

Plot	Treatment	Frequency of harvest	Pounds of green matter per acre					
			1909	1910	1911	1912	1913	Total for five seasons
1	None	Once a week	4 968	3 660	3 182	2 408	1 141	15 359
2	None	Once every 2 weeks	6 232	4 624	3 417	2 618	1 248	18 139
3	Double-disked once in spring	Once a week	5 613	4 680	4 121	2 584	1 268	18 266
4	Double-disked once in spring	Once every 2 weeks	5 678	5 246	4 249	2 578	1 239	18 990
5	Double-disked once in spring, manured	Once a week	11 596	13 004	13 863	6 337	4 974	49 774
6	Double-disked once in spring, manured	Once every 2 weeks	12 548	13 910	12 638	5 259	3 760	48 115
7	None	Twice a year	6 024	6 792	5 919	2 970	2 792	24 497

was then evaluated according to the effect it had on the yield and protein content.

Method of harvesting. On each harvest date the entire area of each plot was harvested with a hand-operated lawn mower equipped with a grass catcher. The mower was always set to cut the grass at the same height, and the mowing was done in the afternoon after moisture from dew or rain had evaporated. The clippings were collected in metal cans with tight covers.

Method of sampling. Two or three pounds of the forage from each plot was air-dried in wire-mesh trays with the help of an electric fan. The trays were 3 feet square and 6 inches deep and lined with thin muslin. The air-dried samples were then finely ground and analyzed for moisture, nitrogen, ether extract, and ash.

All in all, more than 400 samples of bluegrass were analyzed and more than 2,000 chemical determinations made.[1]

Frequent Harvesting Reduced Yield

The effect of the frequency of harvest was studied by mowing three plots (Nos. 1, 3, and 5) weekly and three comparable plots (Nos. 2, 4, and 6) biweekly from about May 1 to October 1 (except in 1911 when the harvests were continued thru October).

[1]Tables showing the detailed chemical analyses covering this investigation, together with full description of the plan of the experiment, are contained in a typewritten volume deposited in the Agricultural Library of the University of Illinois.

Yearly yield of dry matter. In 10 of the 12 comparisons (Table 2), the plot mowed weekly yielded less forage than the comparable plot mowed biweekly. An exception to the rule occurred between the manured plots (5 and 6) in 1911, and again in 1912. The total difference in yield between the manured plots, however, was less than the total difference in yield between the disked plots or between the untreated plots.

Plot 7, which like Plots 1 and 2 received no treatment, was harvested only twice yearly—in mid-June and in mid-September. Its yield,

TABLE 2.—DRY-MATTER YIELDS OF BLUEGRASS HARVESTED WEEKLY AND BIWEEKLY, 1910-1913

Plot	Treatment	Frequency of harvest	Pounds of dry matter per acre				
			1910	1911	1912	1913	Total for four seasons
1	None	Weekly	1 135	920	754	387	3 196
2	None	Biweekly	1 464	1 071	818	449	3 802
	Difference in favor of biweekly harvest		329	151	64	62	606
3	Disked	Weekly	1 440	1 168	826	411	3 845
4	Disked	Biweekly	1 534	1 230	829	431	4 024
	Difference in favor of biweekly harvest		94	62	3	20	179
5	Disked and manured	Weekly	3 660	3 184	1 764	1 033	9 641
6	Disked and manured	Biweekly	3 955	3 137	1 483	1 099	9 674
	Difference in favor of biweekly harvest		295	−47	−281	66	33

on a green-matter basis (Table 1), was larger than the yield of the comparable plots (1 and 2), which were harvested at weekly and biweekly intervals respectively. It also supplied more total forage than the disked plots (3 and 4), which were mowed weekly and biweekly.

Frequent harvesting almost invariably reduced the yearly yield of dry matter.

Percent of protein in dry matter. Forage harvested weekly was higher in protein than forage harvested biweekly (Table 3). This was probably because of the natural tendency of new grass to have a greater protein content than old grass.

Yearly yield of protein. Altho weekly mowing increased the percent of protein in the dry matter, it reduced the yield of dry matter so much that there was little difference between the total protein yield of a plot mowed weekly and a comparable plot mowed biweekly. In 12 comparisons (Table 4) the plot mowed weekly yielded more protein 6 times and the plot mowed biweekly, 6 times.

TABLE 3.—PROTEIN CONTENT OF BLUEGRASS HARVESTED WEEKLY AND BIWEEKLY

Plot	Treatment	Frequency of harvest	Percent of protein in dry matter				
			1910	1911	1912	1913	Average for four seasons
1	None	Weekly	17.2	22.6	17.5	16.5	18.7
2	None	Biweekly	16.7	20.7	15.9	15.9	17.6
	Difference in favor of weekly harvest		.5	1.9	1.6	.6	1.1
3	Disked	Weekly	18.0	23.6	17.3	16.5	19.4
4	Disked	Biweekly	16.2	21.7	16.0	16.3	17.9
	Difference in favor of weekly harvest		1.8	1.9	1.3	.2	1.5
5	Disked and manured	Weekly	21.4	25.9	20.4	20.1	22.6
6	Disked and manured	Biweekly	20.1	22.6	17.8	20.4	20.6
	Difference in favor of weekly harvest		1.3	3.3	2.6	−.3	2.0

TABLE 4.—PROTEIN YIELDS OF BLUEGRASS HARVESTED WEEKLY AND BIWEEKLY

Plot	Treatment	Frequency of harvest	Pounds of protein per acre				
			1910	1911	1912	1913	Total for four seasons
1	None	Weekly	196	207	132	64	599
2	None	Biweekly	244	222	130	71	667
	Difference in favor of weekly harvest		−48	−15	2	−7	−68
3	Disked	Weekly	259	276	143	68	746
4	Disked	Biweekly	249	267	132	70	718
	Difference in favor of weekly harvest		10	9	11	−2	28
5	Disked and manured	Weekly	783	823	359	208	2 173
6	Disked and manured	Biweekly	795	708	264	225	1 992
	Difference in favor of weekly harvest		−12	115	95	−17	181

The yearly yield of protein averaged a little higher for plots mowed weekly than for the plots mowed biweekly. This advantage of weekly mowing was so slight, however, that it was more than offset, for practical purposes, by the reduction it caused in yield. Hence in considering the seasonal yields of both forage and protein it appears that constant close grazing of bluegrass pastures should be avoided.[1]

Disking Increased Yield

As soon as the ground was sufficiently dry each spring, two otherwise untreated plots (Nos. 3 and 4) were thoroly disked lengthwise and crosswise as many times as possible without turning the sod

[1]See Bul. 505 of this Station for reports of experiments in which bluegrass pastures were used as part of a rotational grazing system.

TABLE 5.—DRY-MATTER YIELDS OF DISKED AND UNDISKED BLUEGRASS

Plot	Treatment	Frequency of harvest	Pounds of dry matter per acre				
			1910	1911	1912	1913	Total for four seasons
1	None	Weekly	1 135	920	754	387	3 196
3	Disked	Weekly	1 440	1 168	826	411	3 845
	Difference in favor of disking		305	248	72	24	649
2	None	Biweekly	1 464	1 071	818	449	3 802
4	Disked	Biweekly	1 534	1 230	829	431	4 024
	Difference in favor of disking		70	159	11	−18	222

upside down. They were then rolled with a smooth iron roller 3 feet in diameter.

Yearly yield of dry matter. Disking increased the yield of dry matter markedly. The disked plot yielded more forage than the comparable undisked plot in 7 of the 8 comparisons (Table 5).

Percent of protein in dry matter. Disking increased slightly the percent of protein in the dry matter. In the 8 comparisons (Table 6), the disked bluegrass had a higher percentage of protein 5 times; the comparable undisked, 2 times; and once there was no difference.

TABLE 6.—PROTEIN CONTENT OF DISKED AND UNDISKED BLUEGRASS

Plot	Treatment	Frequency of harvest	Percent of protein in dry matter				
			1910	1911	1912	1913	Average for four seasons
1	None	Weekly	17.23	22.55	17.49	16.49	18.74
3	Disked	Weekly	17.97	23.59	17.30	16.49	19.38
	Difference in favor of disking		.74	1.04	−.19	0	.64
2	None	Biweekly	16.68	20.72	15.89	15.92	17.56
4	Disked	Biweekly	16.24	21.66	15.98	16.33	17.85
	Difference in favor of disking		−.44	.94	.09	.41	.29

Yearly yield of protein. Disked bluegrass averaged a little more total protein than undisked. In 3 of the 8 comparisons (Table 7) the disked grass yielded 20 to 33 percent more protein than the undisked. Disking, however, caused only a small increase 4 times and a slight decrease once.

While no determinations of the causes of the increase in yield brought about by disking were made, it was assumed that disking destroyed some of the weeds (mostly dandelions) and thus permitted a denser stand of bluegrass.

TABLE 7.—PROTEIN YIELDS OF DISKED AND UNDISKED BLUEGRASS

Plot	Treatment	Frequency of harvest	Pounds of protein per acre				
			1910	1911	1912	1913	Total for four seasons
1	None	Weekly	196	207	132	64	599
3	Disked	Weekly	259	276	143	68	746
	Difference in favor of disking		63	69	11	4	147
2	None	Biweekly	244	222	130	71	667
4	Disked	Biweekly	249	267	132	70	718
	Difference in favor of disking		5	45	2	−1	51

Manuring Increased Both Yield and Protein

Barnyard manure was applied to Plots 5 and 6 at the rate of 23 tons an acre early in the spring of 1908, 1909, and 1910.[1]

Yield of dry matter. Manure always increased the yield of dry matter. In 7 of the 8 comparisons (Table 8) the manured plot yielded more than twice as much forage as the comparable unmanured plot.

TABLE 8.—DRY-MATTER YIELDS OF MANURED AND UNMANURED BLUEGRASS

Plot	Treatment	Frequency of harvest	Pounds of dry matter per acre				
			1910	1911	1912	1913	Total for four seasons
3	Disked	Weekly	1 440	1 168	826	411	3 845
5	Disked, manured	Weekly	3 660	3 184	1 764	1 033	9 641
	Difference in favor of manuring		2 220	2 016	938	622	5 796
4	Disked	Biweekly	1 534	1 230	829	431	4 024
6	Disked, manured	Biweekly	3 955	3 137	1 483	1 099	9 674
	Difference in favor of manuring		2 421	1 907	654	668	5 650

The yield of the plots which were not manured declined from year to year (see Plots 1 and 2 in Table 2 and Plots 3 and 4 above). This progressive decline occurred largely because the soil fertility which was removed with the harvested forage was not restored, altho low rainfall was also a factor in 1912 and 1913.

Percent of protein in dry matter. Manured grass was always richer in protein than comparable unmanured grass. In the 8 comparisons (Table 9) the protein content of the manured grass ranged from

[1] A notation was made in the records that manure was also applied in 1911 at the rate of 20 tons an acre, but no recorded weights of manure for that year were found.

TABLE 9.—PROTEIN CONTENT OF MANURED AND UNMANURED BLUEGRASS

Plot	Treatment	Frequency of harvest	Percent of protein in dry matter				
			1910	1911	1912	1913	Average for four seasons
3	Disked	Weekly	17.97	23.59	17.30	16.49	19.38
5	Disked, manured	Weekly	21.40	25.86	20.38	20.10	22.55
	Difference in favor of manuring		3.43	2.27	3.08	3.61	3.17
4	Disked	Biweekly	16.24	21.66	15.98	16.33	17.85
6	Disked, manured	Biweekly	20.10	22.56	17.83	20.43	20.59
	Difference in favor of manuring		3.86	.90	1.85	3.10	2.74

one-twentieth to one-fifth higher than the protein content of the unmanured grass.

Yearly yield of protein. Altogether the manured plots yielded two to three times as much protein each year as the unmanured (Table 10). This was due both to the increase in the yield of dry matter and to the rise in the percentage of protein.

TABLE 10.—PROTEIN YIELDS OF MANURED AND UNMANURED BLUEGRASS

Plot	Treatment	Frequency of harvest	Pounds of protein per acre				
			1910	1911	1912	1913	Total for four seasons
3	Disked	Weekly	259	276	143	68	746
5	Disked, manured	Weekly	783	823	359	208	2 173
	Difference in favor of manuring		524	547	216	140	1 427
4	Disked	Biweekly	249	267	132	70	718
6	Disked, manured	Biweekly	795	708	264	225	1 992
	Difference in favor of manuring		546	441	132	155	1 274

Bluegrass Thrived With Heavy Rainfall

Rainfall varied a great deal from season to season (Table 11), and yields varied accordingly (Tables 1, 2, 5, and 8). Rainfall was above normal in May, June, and July of 1909 and below normal the same three months of 1911.

Yields of dry matter and the protein content were always higher when rainfall was heavy. In 1913, when rainfall was extremely low from May thru September, the yields fell to one-half to two-thirds the amounts harvested the preceding year.

Manure beneficial in all seasons. The difference between the protein contents of manured and unmanured bluegrass stayed about the same regardless of weather conditions and the development of the

TABLE 11.—RAINFALL AT URBANA DURING PASTURE SEASONS, 1909-1913[a]
(Inches)

Year	May	June	July	August	September	October	Total for six months
1909	5.58	3.75	7.57	2.37	2.36	2.25	23.88
1910	5.35	2.99	2.76	2.62	4.14	1.34	19.20
1911	2.44	.80	.62	3.35	8.90	3.10	19.21
1912	4.16	1.89	3.68	2.06	1.76	2.95	16.50
1913	.56	1.67	1.52	1.44	2.50	4.03	11.72
Fifteen-year average, 1906-1930	3.97	3.50	3.00	3.65	3.35	2.67	20.13

[a]Data are from Illinois Cooperative Weather Bureau.

grass (Fig. 2). Altho dry weather lowered the dry-matter and protein yields of all plots, the manured grass continued to yield more dry matter and protein than the unmanured (Fig. 3).

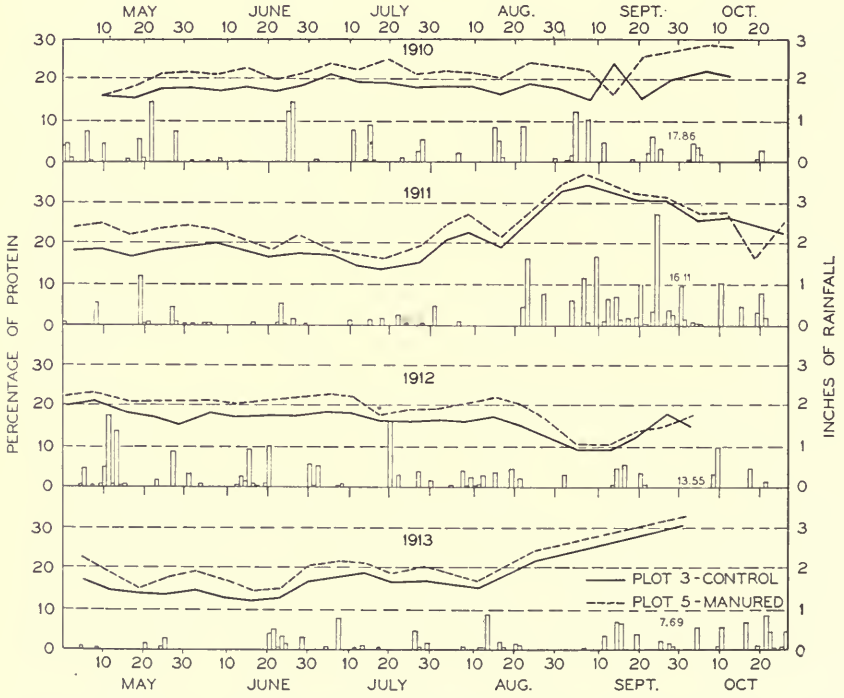

Fig. 2.—Protein content of fertilized and unfertilized bluegrass. Manured grass was consistently higher in protein than unmanured grass during all four seasons. Altho the heavy rains during the latter part of August, 1911, and thru September caused considerable increase in protein content, the difference between fertilized and unfertilized grass remained about the same. (The rainfall from May thru September was 17.86 inches in 1910, 16.11 inches in 1911, 13.55 inches in 1912, and 7.69 inches in 1913.)

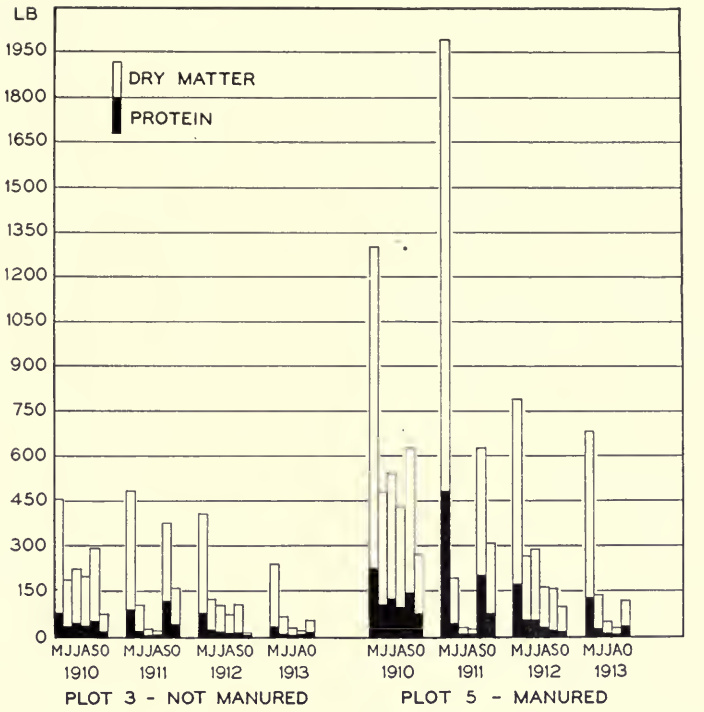

Fig. 3.—Yields of dry matter and protein from fertilized and unfertilized bluegrass plots. The application of barnyard manure had a profound effect on the yields of both dry matter and protein. Grass that was fertilized with barnyard manure had twice as high a dry-matter yield and almost three times as high a protein yield as unfertilized grass.

Reliability of Results

Bluegrass did well under some experimental management practices and poorly under others. To determine whether the different results were caused solely by the three management practices and not partly by chance, all data were analyzed by Student's method[1] (Table 12).

In four instances the odds that the result was caused by factors other than chance were so large that there was no doubt at all that the result was due to the management practice: (1) the effect of frequent harvest on protein content; (2) the effect of manure on yield of dry matter; (3) the effect of manure on protein content; and (4) the effect of manure on yield of protein.

The odds of 58:1 for the effect of disking on dry-matter yield were also large enough to indicate that this practice was the cause of the

[1]STUDENT. The probable error of a mean. Biometrika 6, Part 1, page 19. 1908.

increases obtained. The odds of 12:1 for the effect of frequency of harvest on dry-matter yield and the odds of 15:1 for the effect of disking on protein content were smaller than desirable but still fairly dependable.

TABLE 12.—RELIABILITY OF BLUEGRASS TRIALS

Table	Effect of—	Number of comparisons	Mean value of differences	Odds 1:[a]
2	Frequency of harvest on dry-matter yield	12	68.17	12
4	Frequency of harvest on protein content	12	1.39	3 333
5	Frequency of harvest on protein yield	12	11.75	5
6	Disking on dry-matter yield	8	108.90	58
7	Disking on protein content	8	.32	15
8	Disking on protein yield	8	24.75	4
9	Manure on dry-matter yield	8	1 431	1 508
10	Manure on protein content	8	2.76	10 000
11	Manure on protein yield	8	337.60	1 136

[a]Student's odds that the differences were caused by factors other than chance.

The odds for the effect of frequent harvesting and of disking on yields of protein were, respectively, only 5:1 and 4:1. The results in these two instances, therefore, cannot be considered proof that these two practices are of any benefit. In fact, under ordinary farm conditions neither could be expected to increase the yields of protein in bluegrass pastures.

Summary and Conclusions

Frequent harvesting reduces bluegrass yield. Bluegrass harvested weekly had a slightly higher percent of protein than bluegrass harvested biweekly. Weekly harvesting, however, reduced slightly the yearly yield of dry matter but had no significant effect on the total amount of protein.

Disked bluegrass supplies more forage than undisked. Double-disking once in the spring increased the yearly yield of dry matter to a considerable extent. The percentage of protein was increased only a small extent, while the total amount of protein was not significantly changed.

Manuring increases markedly both the yield and the protein content of bluegrass. The application of barnyard manure more than doubled the yearly yield of dry matter, increased the percent of protein in the dry matter by one-sixth, and nearly trebled the total amount of protein.

Yields declined when grass was harvested over a period of years without fertility being returned to the soil.

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